CHAPTER 10

AQUACULTURE

10-1. General.

a. The CE interest in aquaculture stems from its basic mission in construction and operation of navigable waterways. Due to the increasing difficulty and expense of obtaining dredged material containment acreage for use as single purpose areas, the development of a multiple-use strategy such as aquaculture is desirable. It is possible that future site availability would be improved by increased value of acreage leased to dredging project sponsors because landowners could enter separate and profitable lease agreements with aquaculturists. Aquaculture is attractive because of the potential for: (1) producing nutritious low-cost protein; (2) partially satisfying increased demand for seafood in the United States; (3) increasing employment in fish farms, feed mills, processing plants, and other supporting industries; and (4) providing larval stock for commercially and recreationally important natural populations currently stressed due to pollution and habitat loss. Aquaculture activities would also generate a more positive public image of the CE and its activities.

b. Aquaculture in a dredged material containment area was first explored by the CE during the Dredged Material Research Program. In 1976, Dow Chemical Company, under contract to the CE, successfully cultured a crop of white shrimp in an active containment area near Freeport, Texas (Figure 10-1). This project demonstrated that dredged material containment site environments are compatible with aquaculture in the sense that animals will grow, survive, reach marketable size, and be of marketable quality. No attempt was made to justify the project’s production economics; the cost of postlarval white shrimp stock, the limited acreage, and the small size of the unfed white shrimp at the time they were harvested all contributed to high production costs (item 52).

10-2. Aquaculture Concept.

a. Advances in Technology. Many of the technology problems which affected production economics during the 1976 dredged material demonstration at Freeport, Texas, have been reduced through continuing research on the biology and culture requirements of desirable plant and animal species. It is now possible, for example, under laboratory conditions, to duplicate the life cycle of the white shrimp species used in that study. One advantage of this technology is a reduced cost of obtaining juvenile shrimp compared with the cost of field excursions for capturing egg-carrying and recently mated female shrimp in the wild, and returning them to a laboratory for spawning. Another very significant advantage is that artificial control over the natural reproductive cycle permits production of juvenile shrimp whenever they are needed and allows production of multiple crops in a single growing season.

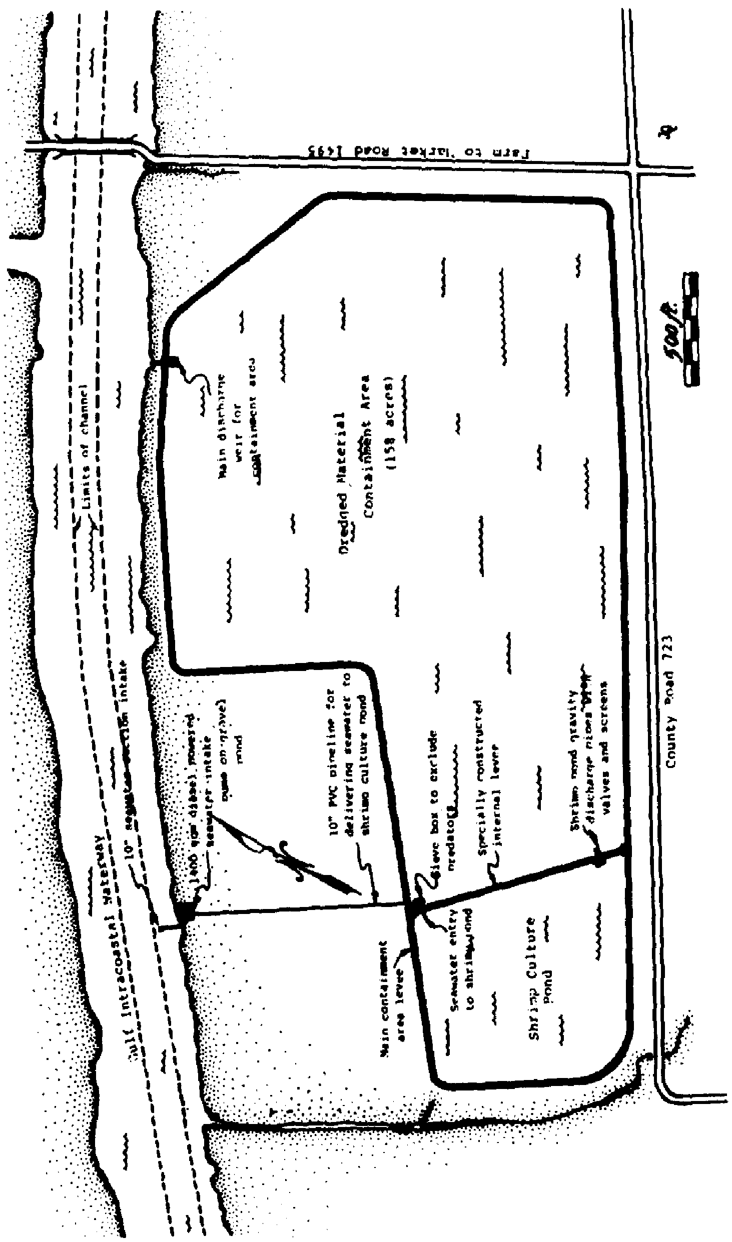

Figure 10-1. Galveston District dredged material Containment Area No. 85, showing the shrimp pond, internal levee, and associated structures

The result is more efficient use of the cultivation area, higher annual production, and lower net production costs.

b. Favorable Economics.

(1) Dredged material containment sites commonly possess structural features such as dikes and water control devices that may enhance their suitability as aquaculture areas. In some instances, land acquisition costs (purchase or lease) and dike and water control structure costs are absorbed wholly or in part by the Federal government or a local cooperator on the dredging project, such as the city government or port authority. In cases where a Federal or local subsidy exists, the aquaculturist could be the beneficiary. The lack of available coastal sites has been one of the principal restraints on the application of commercial aquaculture techniques. This is due both to the cost of real estate and to the Government’s regulatory permitting process which affects consideration of aquaculture in coastal lowlands, particularly wetlands. Freshwater and coastal dredged material containment areas have several benefits related to desirable location: (a) proximity to favorable water sources, (b) waterfront property use that may otherwise be unavailable to the aquaculturist, and (c) nearness to large market areas and established transportation routes.

(2) Dikes that would serve to contain the dredged material would also serve to impound the water necessary for aquaculture. However, dikes of an existing containment site that is under consideration for aquaculture may have to be modified to increase their height, adjust their slopes, or improve their water-retaining capabilities. At a new containment site, the dikes could be designed to permit both the containment of dredged material and the retention of water for the aquaculture operation. Water control structures that are used to regulate water quality at containment areas could also serve to regulate water exchange rates and levels in an aquaculture pond, and could be used to drain the pond or concentrate the crop for harvesting.

10-3. Aquaculture Considerations.

a. Compatibility Between Aquaculture and Dredged Material Management.

(1) There are at least two general containment site management techniques that could be compatible with aquaculture. Figure 10-2 depicts the placement of dredged material into a containment area surrounded by a single primary dike system. Distribution of the dredged material would be dependent on the size (surface area) of the containment, the relative volume and physical characteristics of the dredged material, and the use of controlled disposal operation conditions such as pipeline placement and movement. It is unlikely, though not impossible, that culture operations could be sustained within the site during active disposal. A small volume of dredged material disposed into a large disposal site containing a species tolerant of suspended sediments is one workable scenario. Figure 10-2 also depicts a containment site divided into multiple compartments or cells which would be filled

sequentially over the life of the disposal site. Construction of secondary, internal cross dikes produces a configuration with numerous operational advantages over an undivided one. The most obvious benefit would be related to the separation of one or more cells from dredged material disposal operations. The second configuration has an additional benefit in a new site because it also separates the aquaculture operation from potentially contaminated dredged material. This is a source of perceived, if not actual, production or marketing problems.

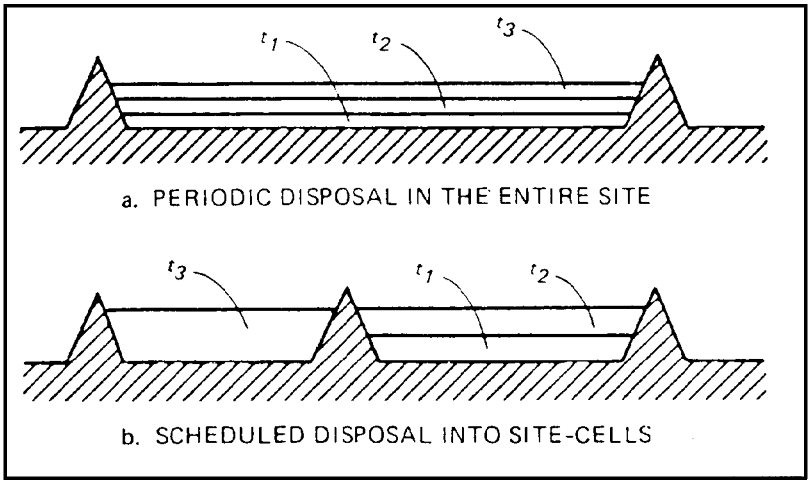

Figure 10-2. Two concepts for combining dredged material containment and aquaculture operations (t = time in years and may vary between 1 and 15 from site to site)

(2) The length of time following a disposal event before aquaculture activities could begin would be a site-specific variable depending on the site’s size and configuration, the volume and character of the dredged material, and the possible use of dredged material dewatering and other volume-reducing techniques for efficient containment site management. A site without cross dikes will not be available to aquaculture during the active dewatering period. Otherwise, aquaculture and dewatering objectives are totally compatible.

b. Aquaculture Products. Aquaculture in containment sites could be designed to produce crops for commercial harvest or could be directed toward producing fish and shellfish stocks for release to augment depressed natural populations. Current aquaculture-for-release programs in California, Texas, the Pacific Northwest, Japan, and the Middle East use natural and artificial coastal ponds, lagoons, and embayments for their propagation programs. Similar programs could easily be undertaken in containment areas.

c. Site Characteristics. Containment sites exhibit a wide range of variability: location, size, construction, compatibility of aquaculture with disposal requirements, and a myriad of other site-specific physical and chemical features which make each containment area unique. Not all containment sites will be suitable for aquaculture, but a significant number have the proper combination of features to support aquaculture. Crucial to developing aquaculture as a secondary use of containment sites is the fact that aquaculture will be possible only if it is compatible with the disposal requirements and schedules imposed by the intended primary use of the site, i.e. dredged material disposal. Only when both the aquaculturist's and the disposal agency's requirements are met can the site be developed for aquaculture.

d. Site Acquisition and Permitting. Site development and pond management practices are expected to be similar to those presently used in commercial aquaculture operations. Major exceptions lie in the areas of site acquisition by entrepreneurs and permit-granting procedures. Existing easement agreements would have to be amended, requiring prospective aquaculturists to reach separate agreements with both the property owner and the CE. Representatives of commercial aquaculture enterprises claim that the current permitting process is so involved and complex that the growth of aquaculture in the United States is effectively thwarted. Having the CE involved in promoting aquaculture in addition to retaining its traditional role in the permitting process could possibly expedite the process in the future.

e. Use of Contaminated Sediment.

(1) Waterway and harbor sediments placed into containment sites are sometimes contaminated with elevated concentrations of heavy metals, pesticides, petroleum hydrocarbons, and PCBs. Inorganic contaminants such as metals are generally incorporated in sediment particles while organic contaminants such as petroleum hydrocarbons and PCBs are generally associated with organic material present in the sediments. Because of the way contaminants are retained within sediments, they are relatively unavailable to aquatic animals; those that are available are generally not concentrated by aquatic animals to levels much in excess of those found in the sediments.

(2) Laboratory experiments in which aquatic animals were exposed to sediments contaminated with various metals and organic contaminants have shown that the organics are more likely to be transferred from sediments to animals. Animals, such as certain marine worms that live and feed below the surface of the sediment, are more likely to accumulate organic compounds like PCBs than most shrimp or clams, which live or feed at or above the surface of the sediment. Higher levels of organic material in the sediment appear to reduce the biological availability of PCBs and other organic chemicals in sediments. There are some data to indicate that animals can accumulate lead and petroleum hydrocarbons from contaminated sediments, but the levels of these contaminants found in these animals are low in comparison to sediment levels, and there is no evidence that they are harmed by these low levels of contamination.

(3) Most studies generally focused on highly contaminated sediments and should be viewed as representing the “worst case.” Containment sites used for the disposal of dredged material with “some contaminants” need not be viewed as a major constraint to their use for aquaculture. Test procedures for determining whether a particular sediment will be a problem to a specific aquacultured species are available, fast, and inexpensive. Contaminant status is something to be aware of and considered during the planning process.

f. Economics. The economic and marketing requirements of commercial finfish and shrimp culture operations and those operations conceived for containment areas are very similar. The capital investment requirements of containment area aquaculture could be significantly less. Simplified land acquisition, reduced real estate costs, shared costs of dike construction and maintenance, and the possibilities of an expedited permitting process would all contribute to reducing capital requirements. Operating costs will depend on site- and species-specific characteristics and are difficult to describe in general terms, but no extraordinary additional costs have been identified.

g. Pond Construction and Management.

(1) Pond construction and modification for aquaculture would be site and species specific. If a containment site satisfied initial geotechnical and engineering requirements, constructing additional dikes, installing water control equipment, and other necessary modifications should follow the procedures employed in conventional operations. Cooperative efforts involving aquaculturists, U.S. Soil Conservation Service (SCS), and the CE are recommended for developing designs and specifying any modifications necessary for using containment areas for aquaculture.

(2) Health considerations, water quality, and species management techniques for containment site culture should be identical to current practices, although the effects of large amounts of fine sediment in the containment area ponds and the lack of experience in managing large-scale aquaculture operations pose questions that still need to be answered. Management procedures for large ponds have not been developed for many species simply because large ponds have not been generally available. With increased availability afforded by the widespread use of containment site acreage, appropriate techniques should evolve. Similarly, adequate water exchange, aeration, and harvest techniques should overcome many difficulties created by the presence of large amounts of fine sediments.

10-4. Feasibility.

a. Aquaculture in active dredged material containment areas appears to be a feasible, cost-effective, and compatible multiple use of containment sites. Existing technology can be- directly applied to the concept, making it practical with little additional research and development investment required. The needs of the local areas, interests of the involved parties, and technical constraints will determine which type of culture operation (commercial or stock augmentation) and which species will be most suitable for a given site. Aquaculture is generally perceived to be only applicable in the U.S. in warmer climates. However, aquaculture is practiced commercially in the Pacific Northwest, California, New England, Chesapeake Bay, and the Carolinas, as well as in Florida and in the Gulf Coast states. Although growth rates are generally slower in colder waters, the concept is still highly applicable.

b. The large successful industries centered on crayfish, salmon, catfish, trout, and bait minnows can provide both the technical expertise and the sources of stock needed for developing a profitable operation. The technology involved in freshwater fish culture is both well defined and compatible with culture plans envisioned for containment areas. Redfish, exotic and native shrimp, hybrid striped bass, bait shrimp, and minnows are the most promising species for marine/brackish water culture.